Pavement Design for Low Volume Roads

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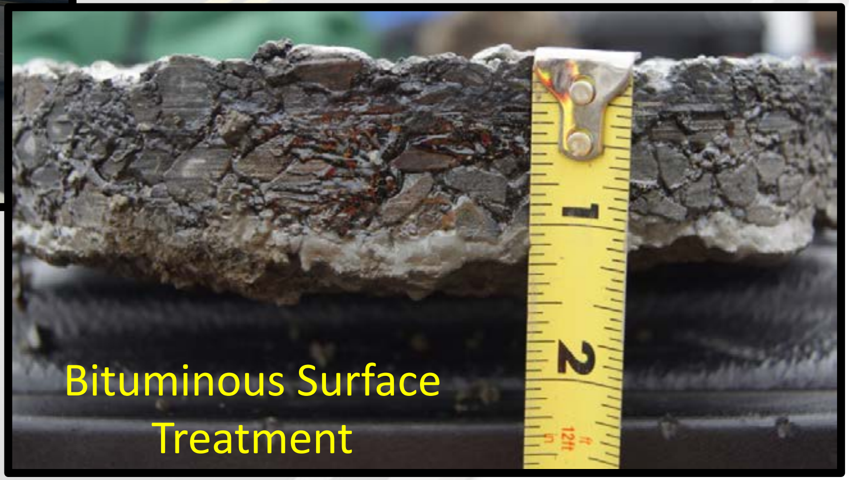
Types of Low Volume Roads?

Photos Courtesy: Washington County, ODOT, and Vestas

Low Volume Road Materials



Low Volume Roads—Failure

Photo Courtesy: Vestas

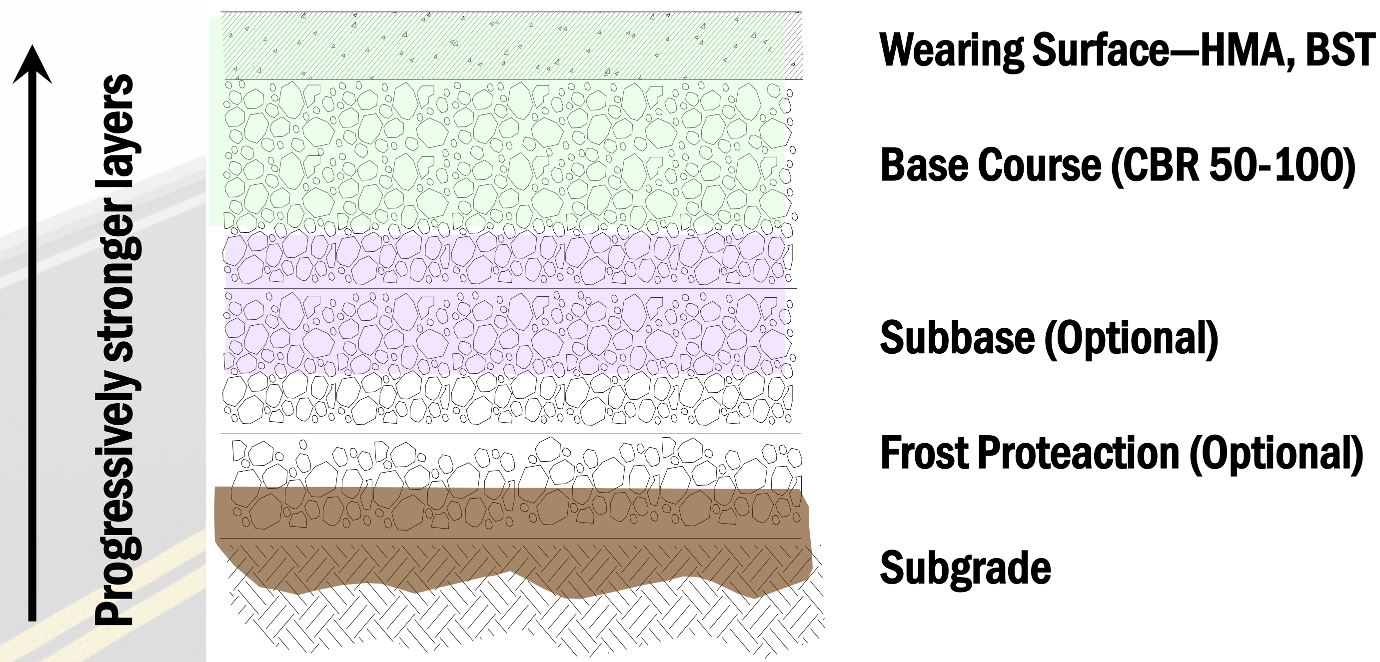
Low Volume Roads—Failure

Photo Courtesy: Vestas

Low Volume Roads—Failures

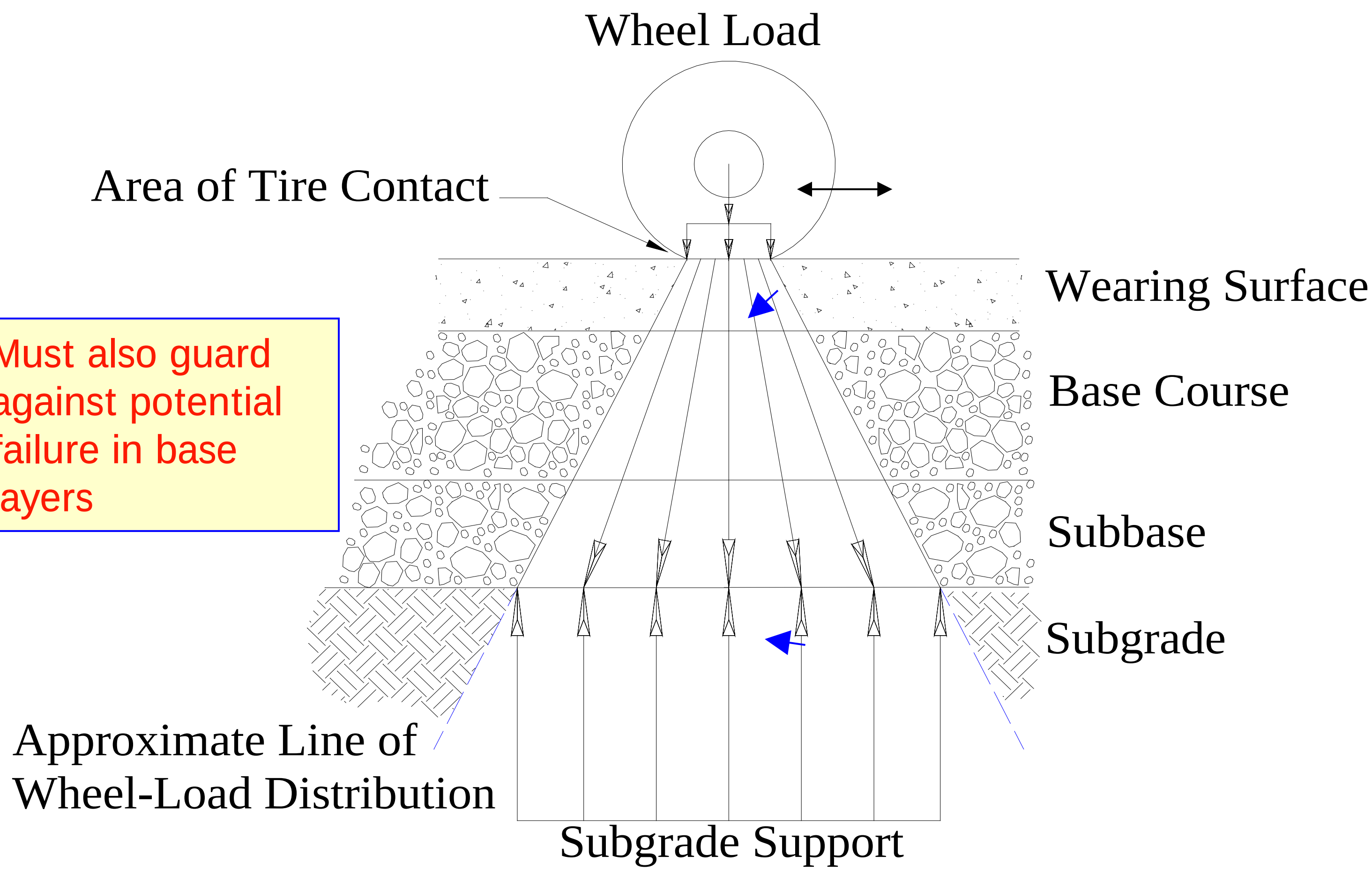
Flexible Pavement Design

Flexible Pavement System



Source: Federal Aviation Administration

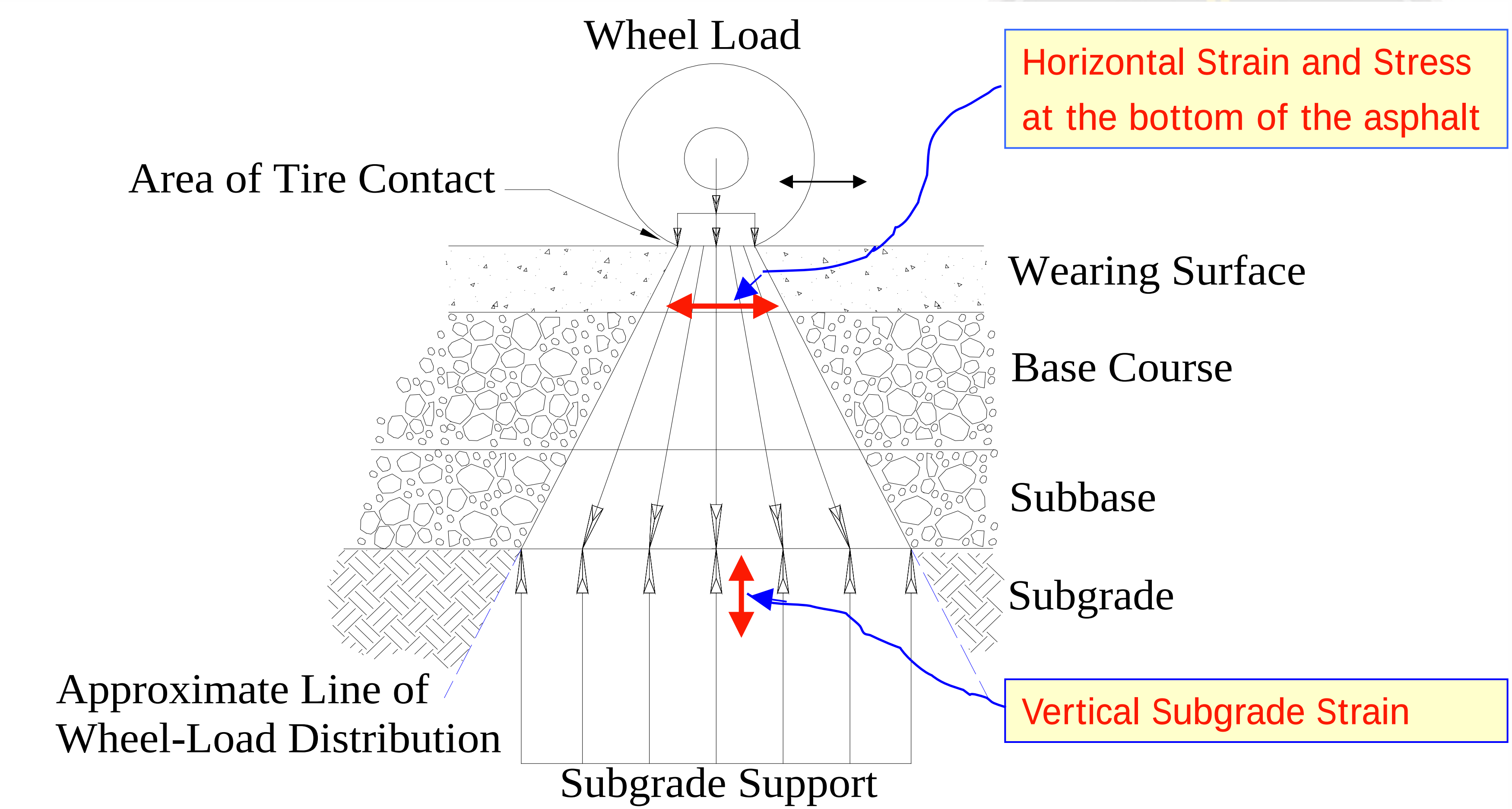
CBR Method



Must also guard against potential failure in base layers

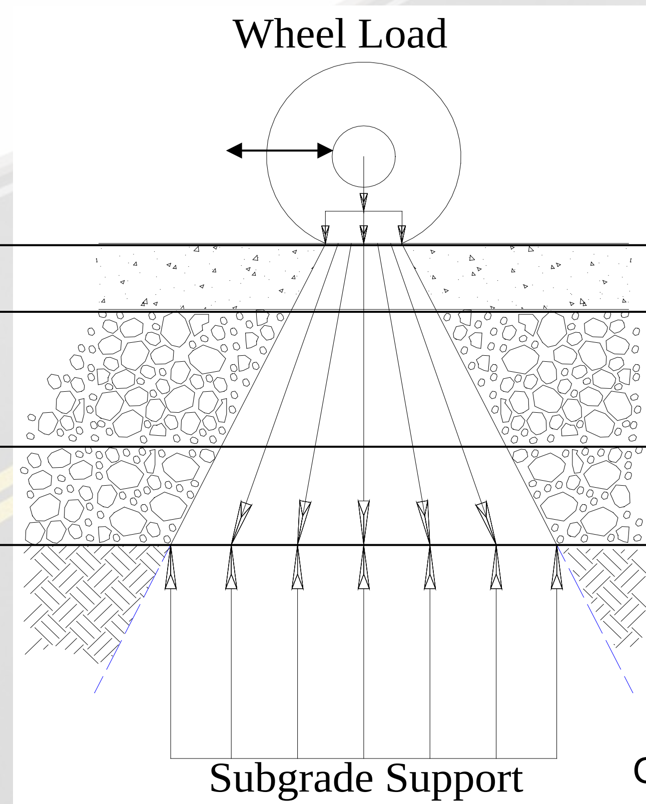
Source: Federal Aviation Administration

Layered Elastic Design—Flexible



Source: Federal Aviation Administration

Flexible Pavement Layer Parameters- LED vs CBR



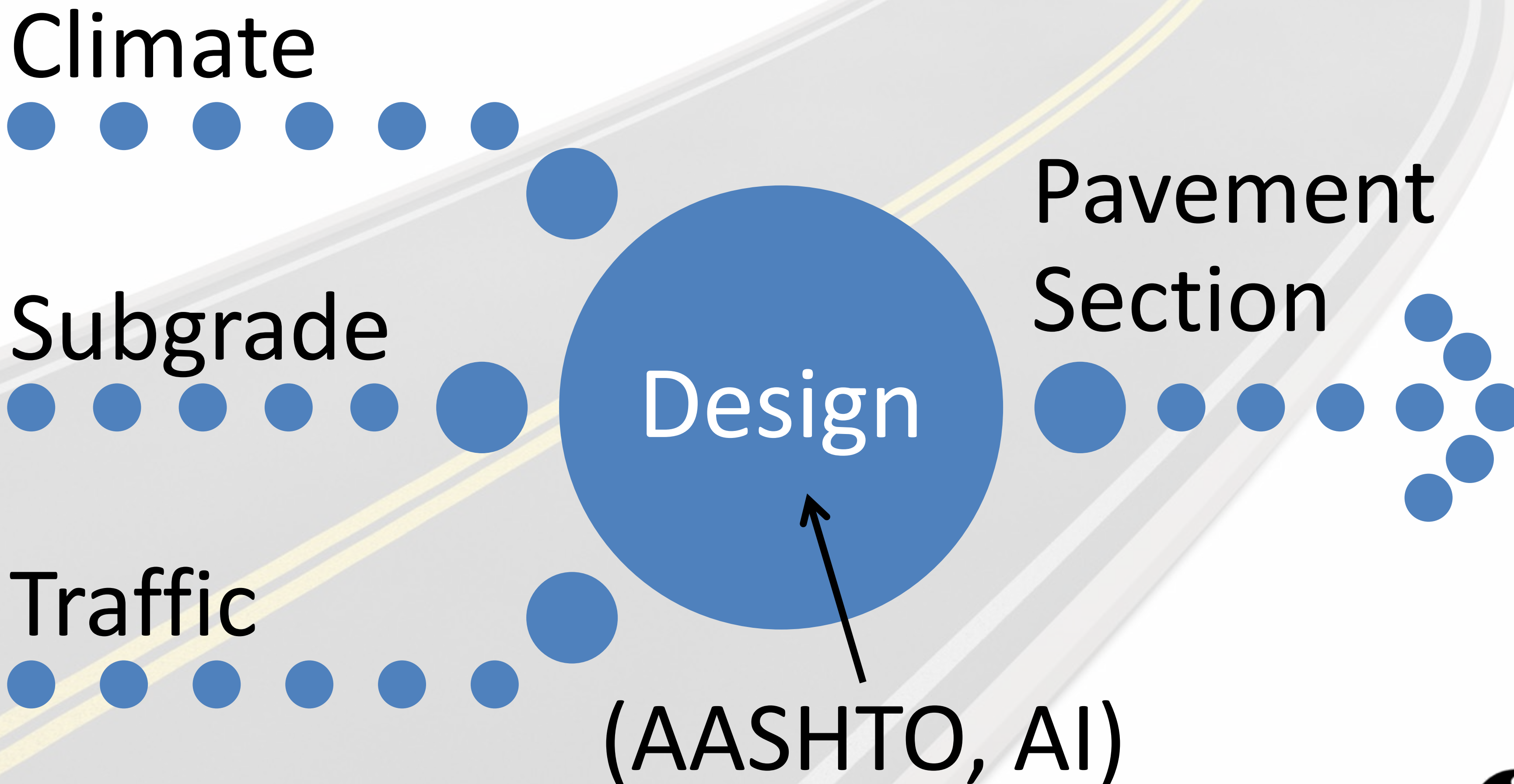
LAYERED ELASTIC METHOD		CBR Method
SURFACE	E_S, μ_S, h	*Not Defined*
BASE	E_B, μ_B, h_B	*CBR*
SUBBASE	E_{SB}, μ_{SB} h_{SB}	*CBR*
SUBGRADE	E_{SG}, μ_{SG} h_{SG}	*CBR*

E = Elastic Modulus
h = thickness
μ = Poisson's Ratio

CBR = California Bearing Ratio

Source: Federal Aviation Administration

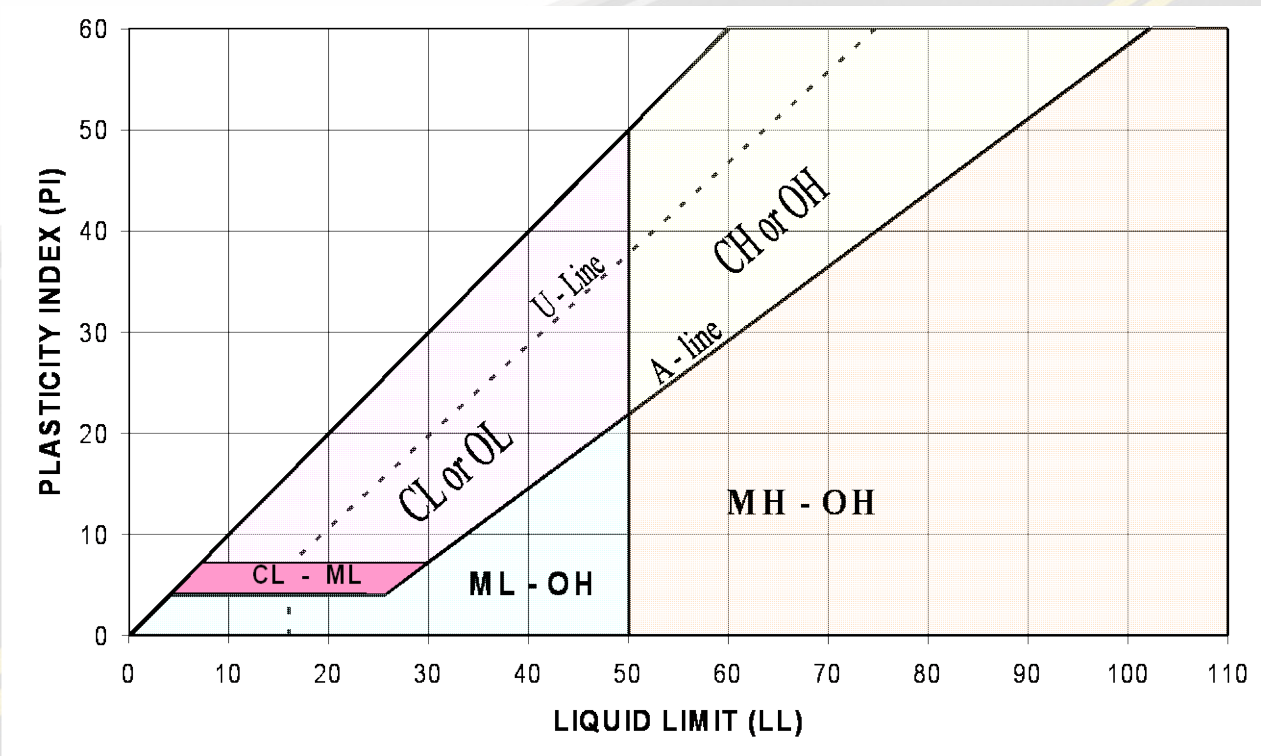
Flexible Pavement Design Process



Start with a Field Investigation

Soil Investigations and Evaluation

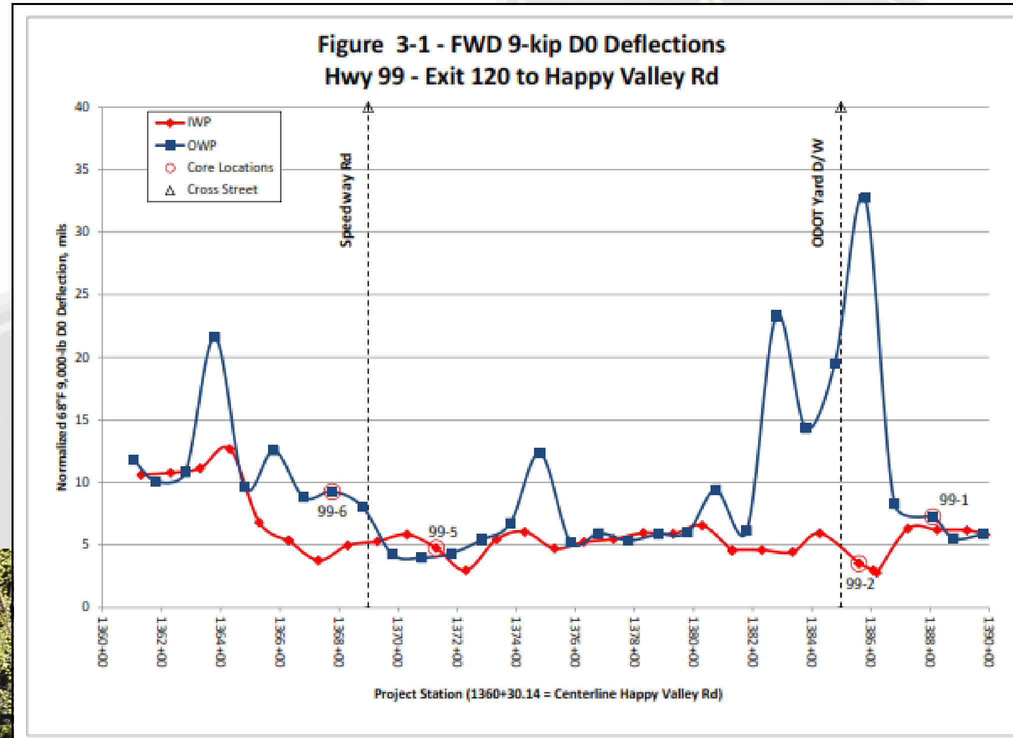
- Unified Soil Classification System (USCS)
  - ASTM 2487



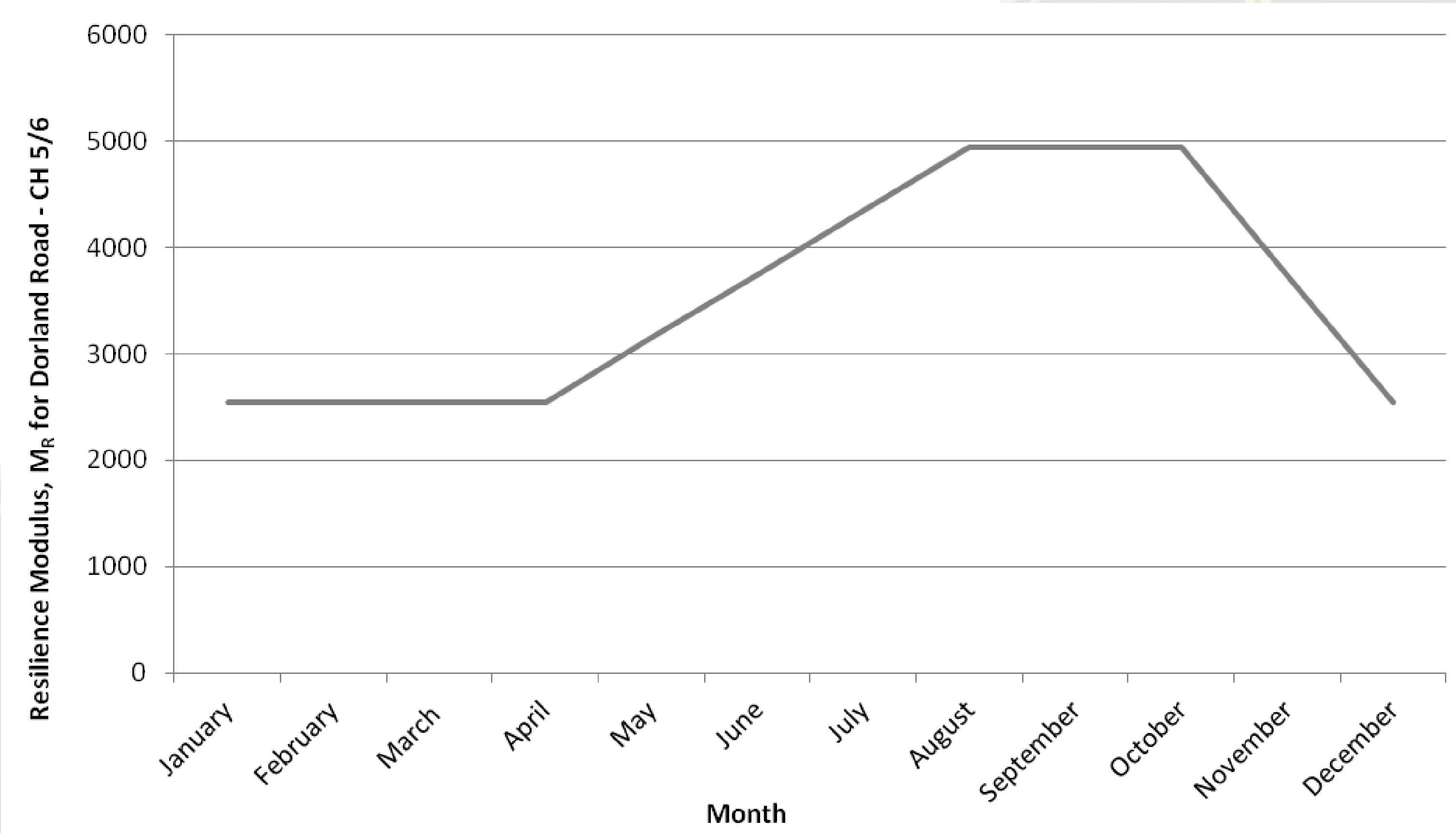
GW	CL
GP	ML
GM	OL
GC	CH
SW	MH
SP	OH
SM	PT
SC	

Field Investigation

Deflection Testing



Seasonal Variation



16th Street ESAL Calculations

- Use 20-year Design Life
- AADT =945 vehicles per day
  - School Buses = 10
  - Delivery Trucks = 4
  - Garbage Trucks = 2
  - Tractor/Semi-trailers = 1
- Traffic Growth Rate = 2% annually

Single Unit (2-axle) Truck

10,000 lb **0.09 ESAL** + 10,000 lb **0.09 ESAL** = **20,000 lb 0.18 ESALs**

Single Unit (3-axle) Truck

18,000 lb	+	42,000 lb	=	60,000 lb
1.00 ESAL		**2.51 ESAL**		**3.51 ESALs**

Tractor Semi-Trailer (5-axle)

12,000 lb		34,000 lb		34,000 lb		80,000 lb
0.19 ESAL	+	**1.10 ESAL**	+	**1.10 ESAL**	=	**2.39 ESALs**

16th Street ESAL Calcs

Class	Vehicle Type	Day	Year	20Y* (k)	Factor	20Y* ESALs
II	Autos	503	183,595	3,672	0.00012	440
III	Pickups	425	155,125	3,103	0.008	24,824
IV	School Buses	10	1,950	39	1.0	39,000
V	Delivery Truck	4	1,460	29	0.18	5,220
VI	Garbage Truck	2	730	15	3.51	52,650
IX	18-Wheelers	1	250	6.1	2.39	14,159
Total		945				136,293

*Adjusted for 2% growth per year

Asphalt Institute SW-1

SW-1 Thickness Design Software - [US 195 Harper to Ironsides]

File Help

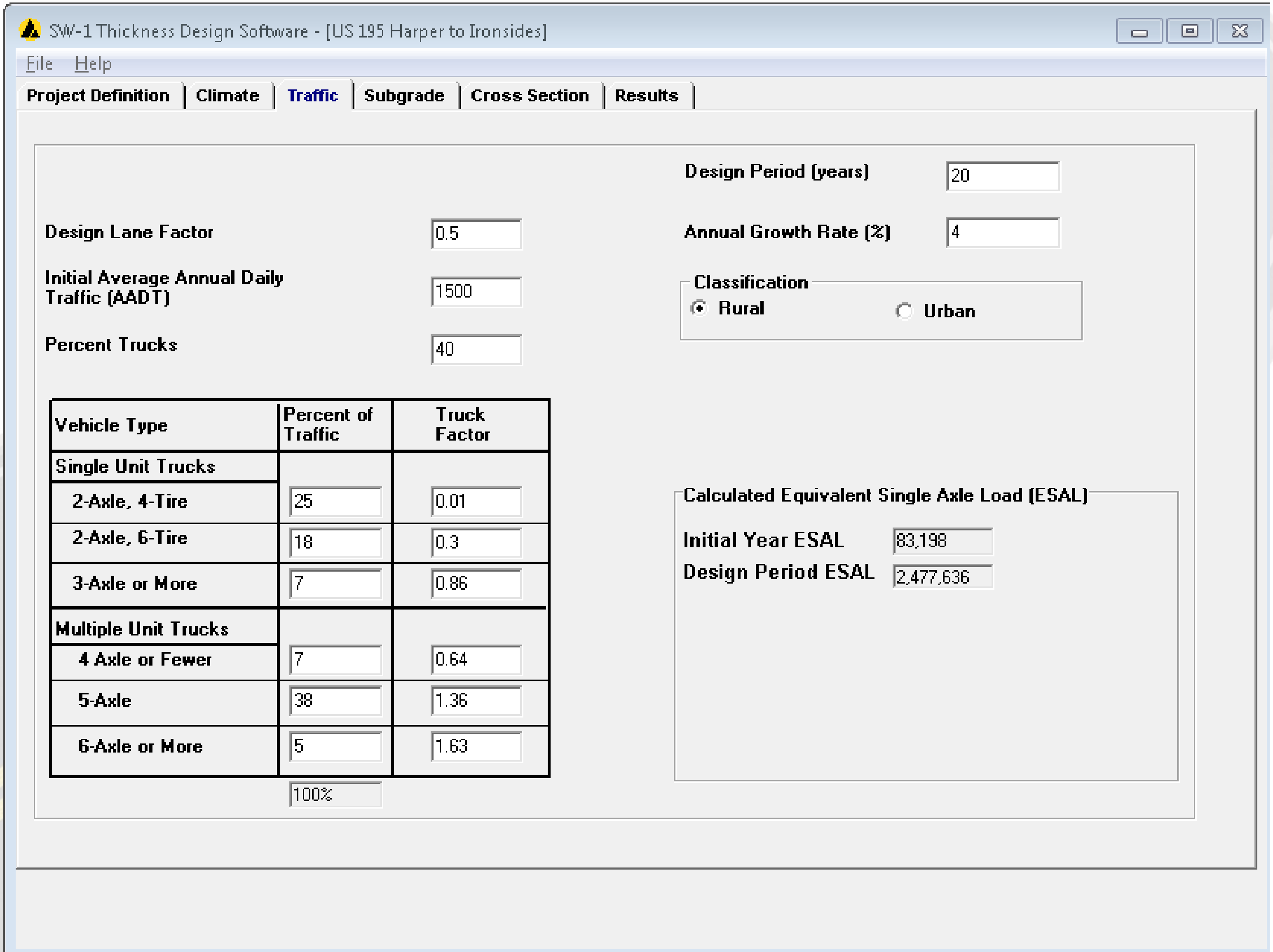
Project Definition | Climate | Traffic | Subgrade | Cross Section | Results

Environmental Conditions (for more information, see MS-1, Chapter III)	
Mean Annual Air Temperature (MAAT)	Frost Effects
≤ 45° F	Yes
60° F	Possible
≥ 75°F	No

Note:

Mean Annual Air Temperature (MAAT) was used to characterize the environmental conditions applicable to the continental United States. For detailed information on the development of the MAAT regions, see Asphalt Institute Research Report RR 82-2 "Research and Development of The Asphalt Institute's Thickness Design Manual (MS-1) Ninth Edition."

Asphalt Institute SW-1



SW-1 Thickness Design Software - [US 195 Harper to Ironsides]

File Help

Project Definition | Climate | Traffic | Subgrade | Cross Section | Results

Design Period (years): 20

Annual Growth Rate (%): 4

Design Lane Factor: 0.5

Initial Average Annual Daily Traffic (AADT): 1500

Percent Trucks: 40

Classification: (•) Rural ( ) Urban

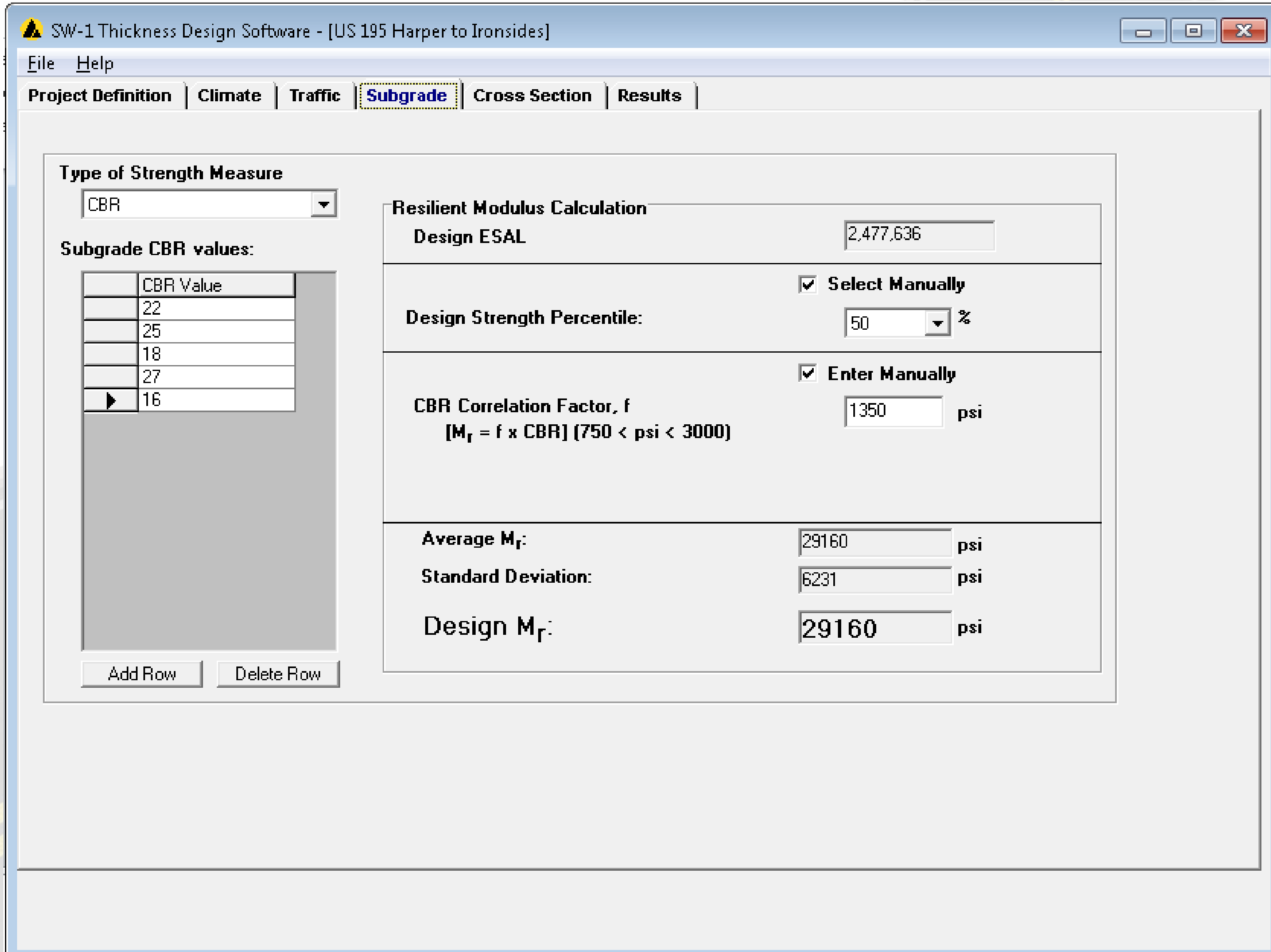
Vehicle Type	Percent of Traffic	Truck Factor
Single Unit Trucks		
2-Axle, 4-Tire	25	0.01
2-Axle, 6-Tire	18	0.3
3-Axle or More	7	0.86
Multiple Unit Trucks		
4 Axle or Fewer	7	0.64
5-Axle	38	1.36
6-Axle or More	5	1.63
	100%	

Calculated Equivalent Single Axle Load (ESAL)

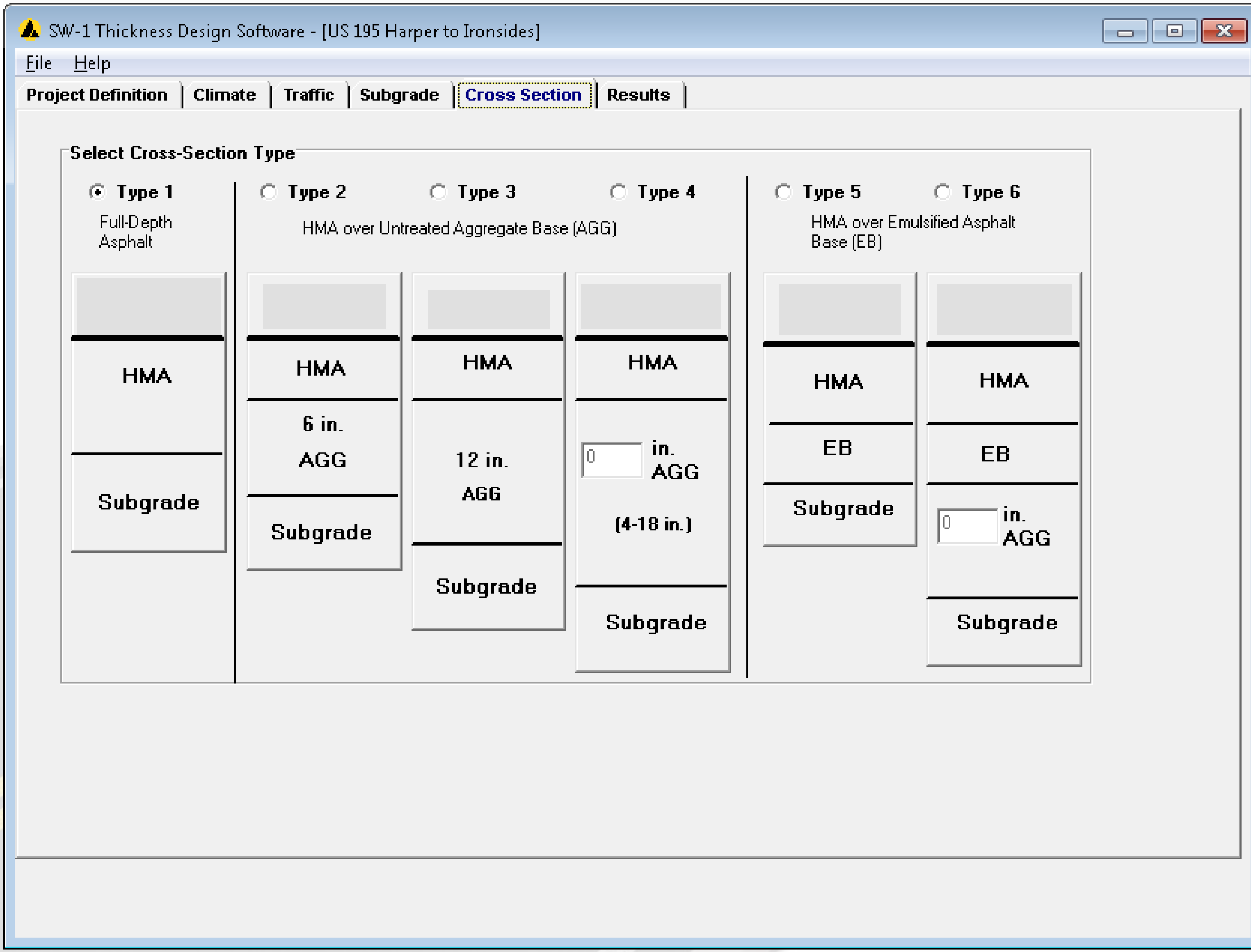
Initial Year ESAL: 83,198

Design Period ESAL: 2,477,636

Asphalt Institute SW-1



Asphalt Institute SW-1



Asphalt Institute SW-1

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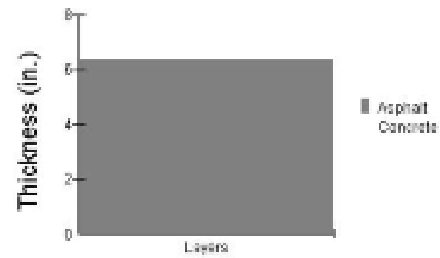
Pavement Design Detail Report

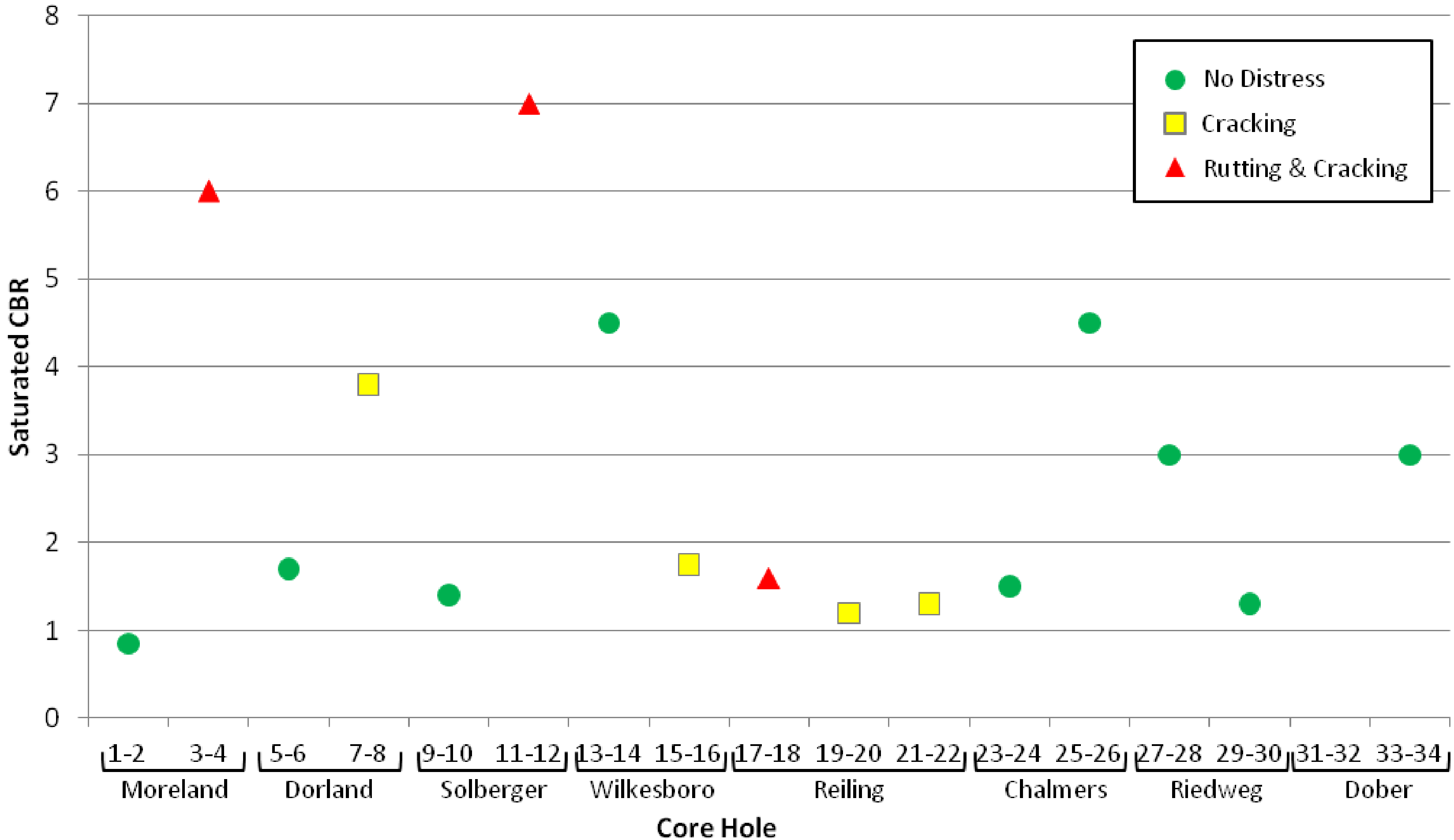
SW-1 Thickness Design Software version 1.0



User:	duvalj	Date:	10/24/2013	Time:	10:11

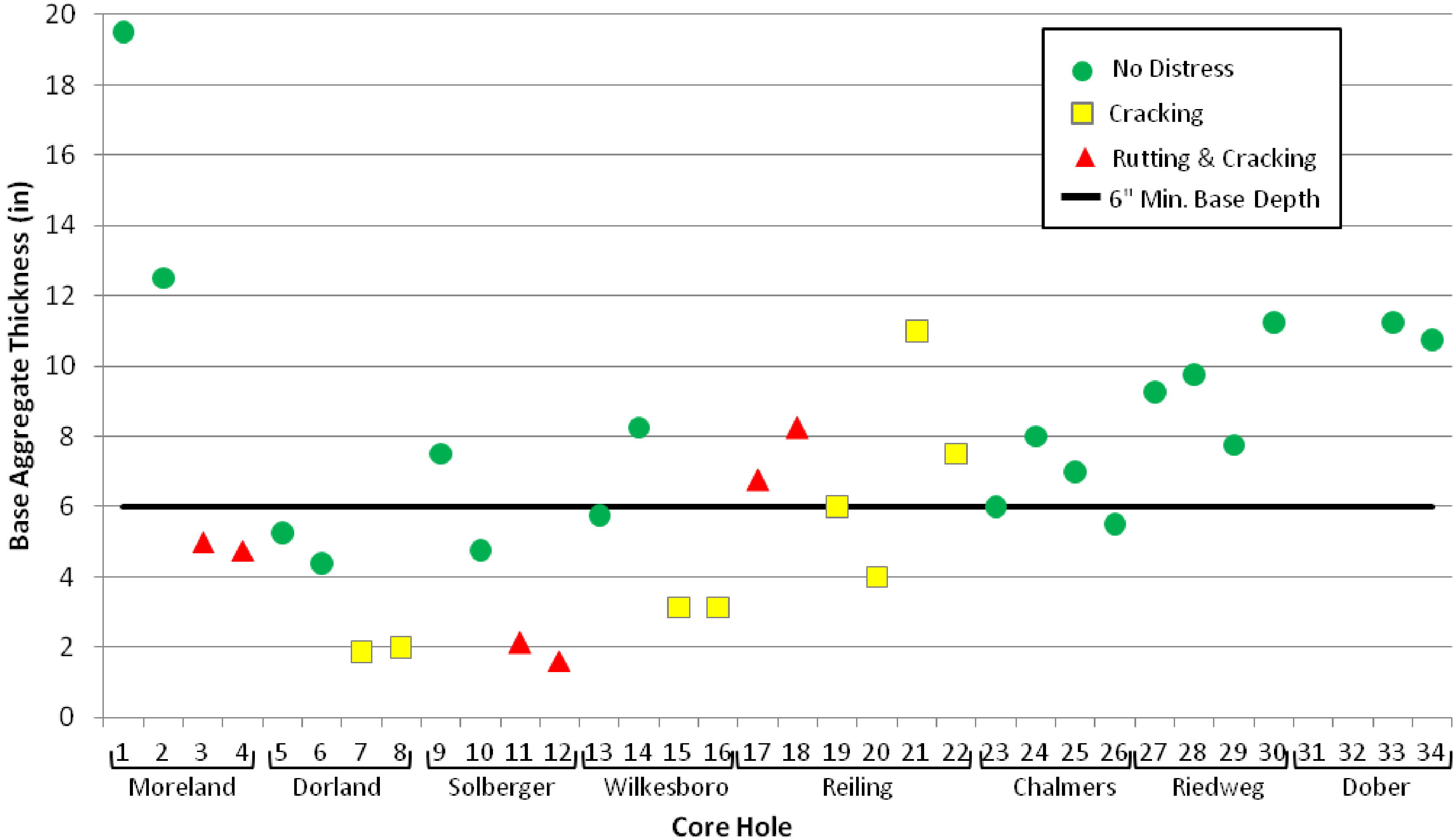
Project Information		
Project Name:	US 195 Harper to Ironsides	
Description:	Example Problem--See SW-1 User's Guide Chapter 8	
Pavement Use:	General Roadway	
Problem Type:	New Pavement Design	
Design Input Summary		
Climate:	45° F	
Design Traffic (ESAL):	2,477,636	
Subgrade M_r (psi):	29,160	
Design Traffic Details		
Design Life (years):	20	
Design Lane Factor:	0.5	
Initial Average Annual Daily Traffic (AADT):	1500	
Truck Volume, as a percentage of AADT:	40	
Annual Compound Growth Rate (%):	4	
Type of usage:	Rural	
Truck Classification	% Trucks	Truck Factor
TRUCK(2-AXLE,4-TIRE)	25	0.01
TRUCK(2-AXLE,6-TIRE)	18	0.30

Results – CBR

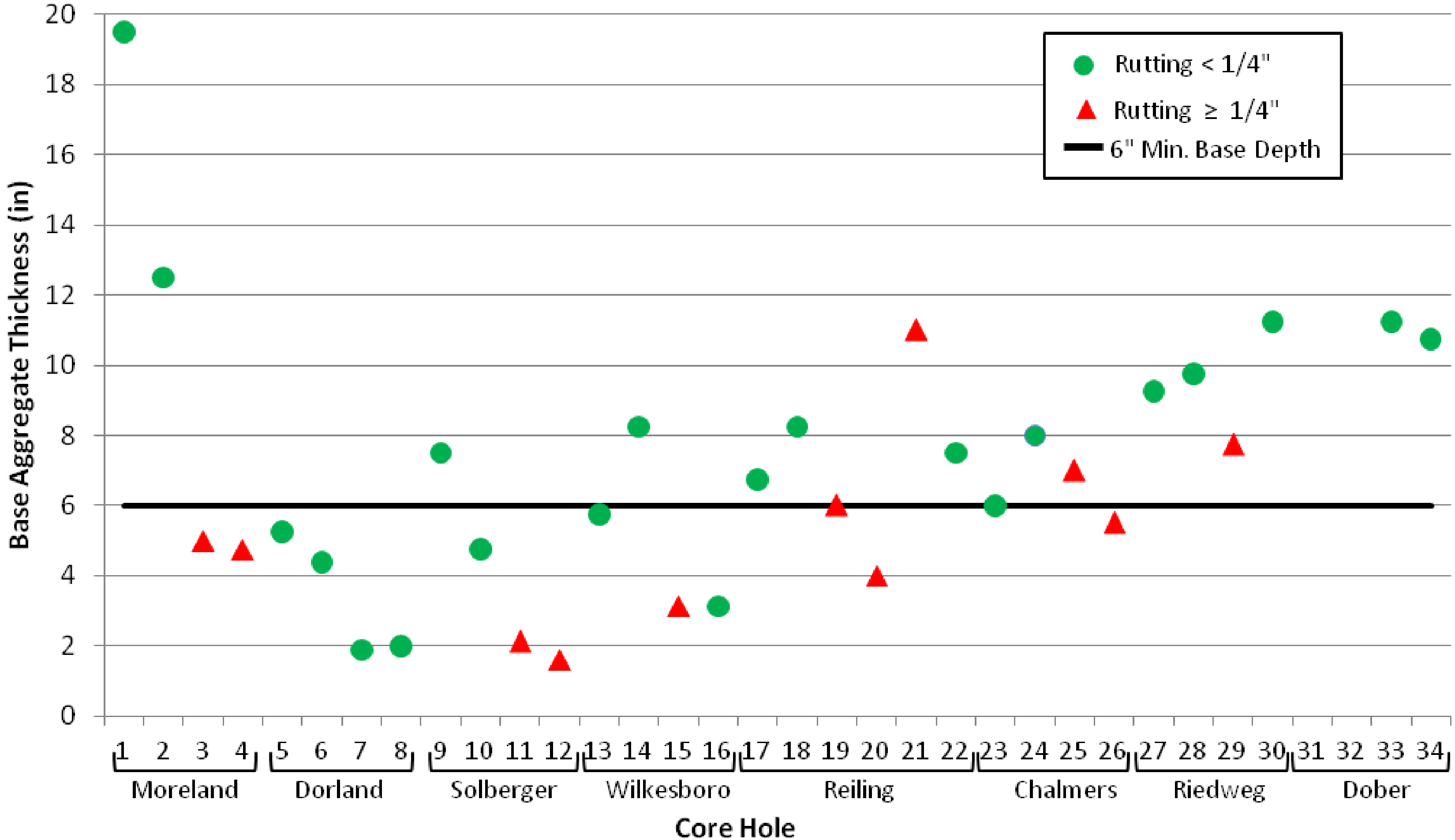


No Distress
Cracking
Rutting & Cracking
Saturated CBR
8
7
6
5
4
3
2
1
0
1-2
3-4
5-6
7-8
9-10
11-12
13-14
15-16
17-18
19-20
21-22
23-24
25-26
27-28
29-30
31-32
33-34
Moreland
Dorland
Solberger
Wilkesboro
Reiling
Chalmers
Riedweg
Dober
Core Hole

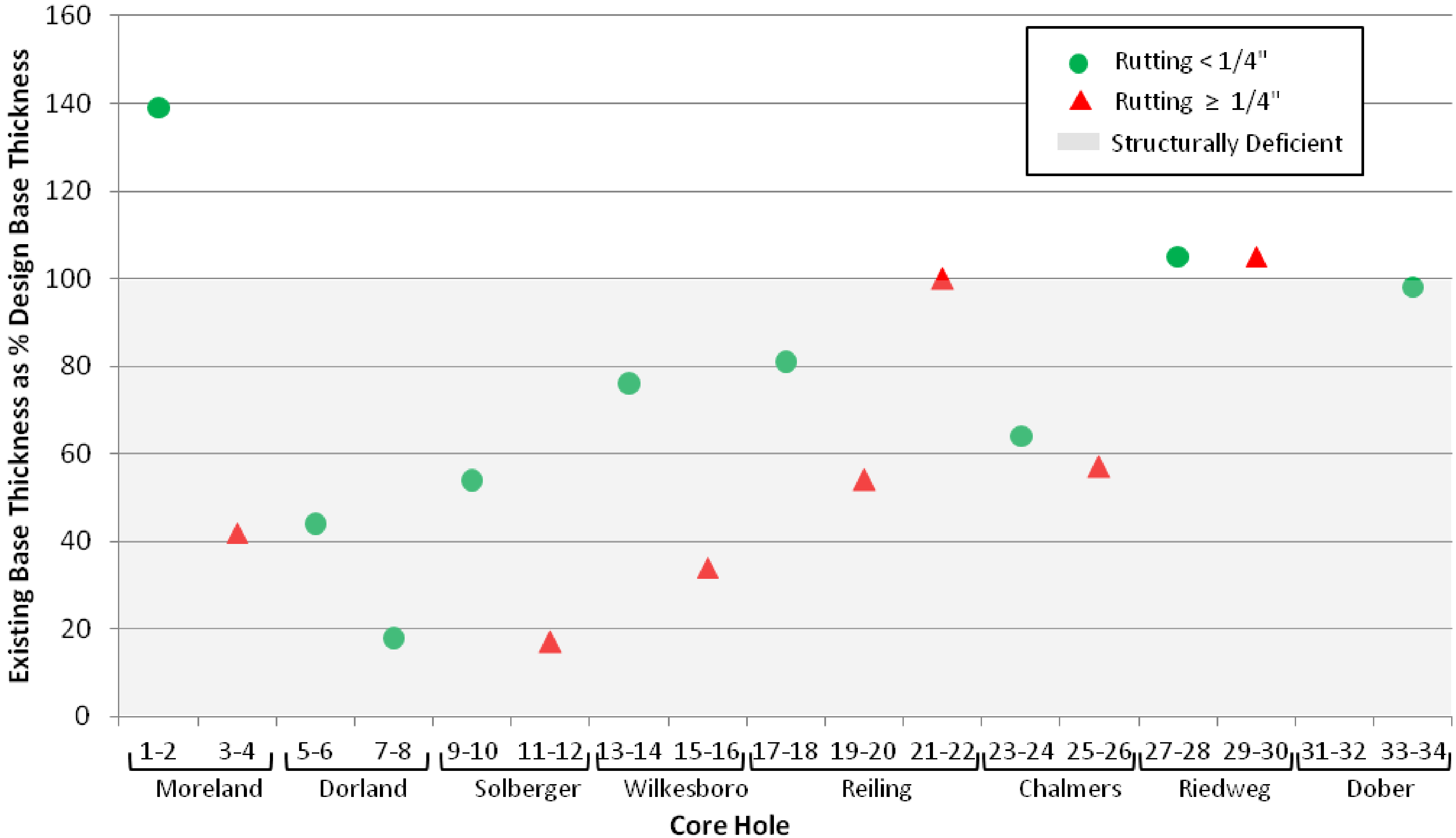
Results – Base Thickness



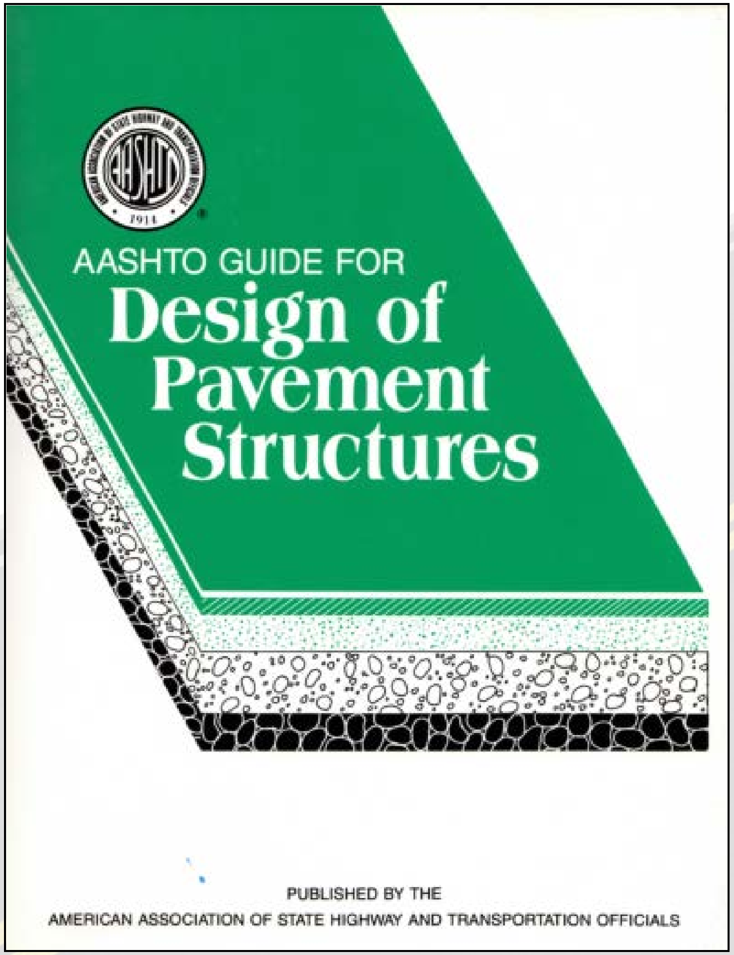
Results – Base Thickness

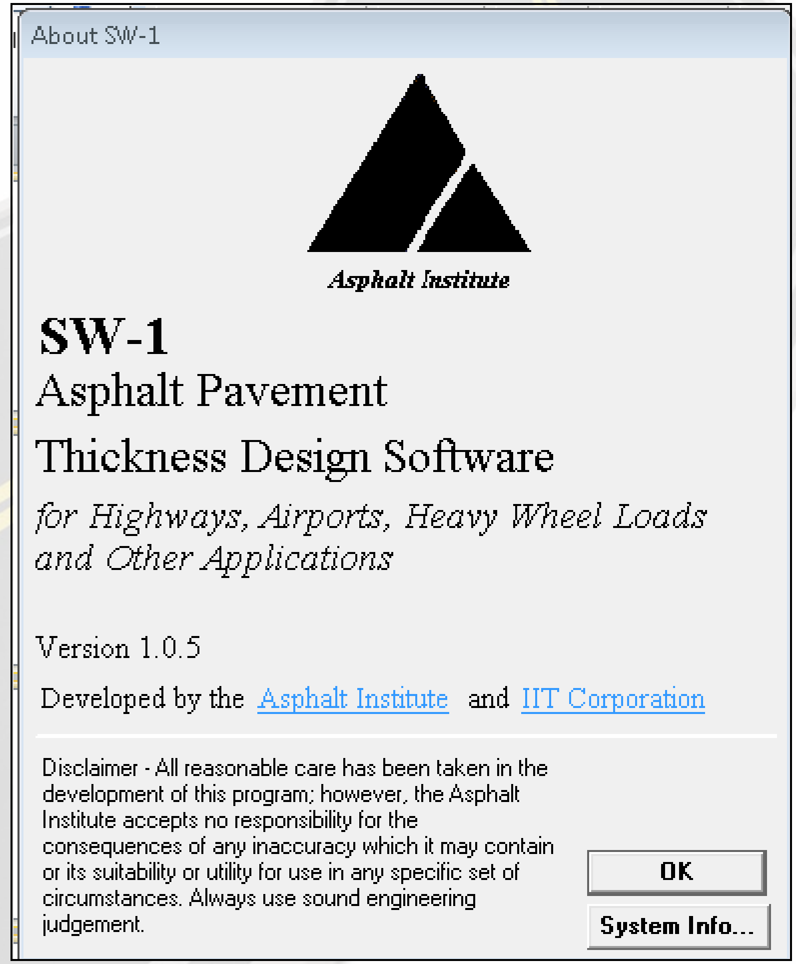


Results – % Design Thickness



Resources


AASHTO GUIDE FOR
Design of Pavement Structures
PUBLISHED BY THE
AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS


About SW-1
Asphalt Institute
SW-1
Asphalt Pavement
Thickness Design Software
for Highways, Airports, Heavy Wheel Loads and Other Applications
Version 1.0.5
Developed by the Asphalt Institute and IIT Corporation
Disclaimer - All reasonable care has been taken in the development of this program; however, the Asphalt Institute accepts no responsibility for the consequences of any inaccuracy which it may contain or its suitability or utility for use in any specific set of circumstances. Always use sound engineering judgement.
OK
System Info...





Pavement Design for Low Volume Roads

Thank You!

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